蝶と蛾 *Tyô to Ga*, **41** (1) : 1－6, 1990

A Study on Hybridization of Two Subspecies of *Papilio bianor* (Lepidoptera, Papilionidae) in Taiwan

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Abstract *Papilio bianor kotoensis* and *P. bianor takasago* are sometimes treated as different species. A present hybridization study confirmed that they are conspesific.

Key wards Lepidoptera, *Papilio bianor kotoensis, Papilio bianor takasago,* hybridization, food habit.

Papilio bianor kotoensis SONAN occurs in Lanyu and Green Island — two islets off the coast of Taitung Hsien. The colors and stripes of the adults differ from those of *P. bianor takasago* NAKAHARA & ESAKI of Taiwan. However, they are usually treated to be conspecific judging from the reproductive organs (SHIRÔZU, 1960). Recently, there are many collecting records in Taiwan on the intermediate individuals of these two subspecies. It is possible that after being introduced into Taiwan through various ways, *P. bianor kotoensis* might cross with *P. bianor takasago* naturally. It comes the result that their offsprings more or less possess the hereditary factors of *P. bianor kotoensis,* such as bright-colored markings, in the field of Taiwan. However, some researchers still agree that *kotoensis* and *takasago* are of the different species. Reproductive ability of the hybrid offsprings in Taiwan is still a question.

Under such circumstances, I introduced *P. bianor kotoensis* several times in 1986 and fed them indoors in order to make hybridization tests.

Food Habit

The larval food of *takasago* in the field in Taiwan would be *Evodia glauca* and *Zanthoxylum ailanthoides,* while that of *kotoensis* in Lanyu would be *Z. ailanthoides* and *Toddalia asiatica.* When they were reared indoors, I did not find any rejection of food and poor growth both in *kotoensis* fed on E. *glauca* and in *takasago* fed on *T. asiatica.*

In Taiwan, various records indicate that the larvae of takasago could feed on *Citrus* species. However, there have been no records in the field. In December 1986, I made a test by feeding 30 1st instar larvae of *kotoensis* on *Citrus* species. Although no rejection of food was observed in early stages, many larvae died in every instar. As a result, only two adults emerged after 6th instars. Therefore in the field, *Citrus* species is not possible to be the usual food of *P. bianor.*

Immature Stages of *P. bianor kotoensis*

When *kotoensis* was reared at 25－30℃, it took about 4 days for egg stage, about 21－24 days for larval stage and about 12－14 days for the pupal stage of non-diapausing individuals. These values are not so different from those of *takasago*. As for the shape and apperance, there were vivid differences between both larvae and pupae of *takasago* and those of *kotoensis*. However, there were great individual variations in colors and stripes even in the larvae or pupae of *takasago* (or *kotoensis*) which had the same parent. The colors of pupae varied between two color systems, green and brown; fresh-green, yellow-green, yellow-brown and brown. It could be sure that the color of diapausing pupae belonged to two extreme color types, i.e., fresh-green and dark brown. The pupal stage of diapausing individual varied from nearly 2 months to more than half a year.

Similarly to many papilionid butterflies, more than two thirds of larvae of *kotoensis* reared in the end of autumn or in the winter in Taipei were transformed into diapausing pupae. But when reared in the spring or summer, most species of the plain area (including *P. bianor takasago*) did not produce diapausing pupae. Furthermore, 12 out of 39 thoroughbred individuals of *kotoensis* reared in the period between April and May in 1987 were observed to enter diapause. In addition to the observation, almost all of the F_1 of *kotoensis* fed by a butterfly marchant nearly at the same season at Puli Cheng, Taichung County became diapausing pupae. Factors affecting diapause induction in *kotoensis* is worth studying.

Hybridization between *P. bianor kotoensis* and *P. bianor takasago*

On March 1, 1987, by hand-pairing technique, I successfully mated a female of *kotoensis* (emerged Feb. 19) and a male of *takasago* (emerged Feb. 28). The female began to lay eggs on March 2. A total of 157 eggs were obtained and only 34 eggs hatched as shown in Table 1. A total of 29 adults (18 ♂, 11♀) emerged from April 11 to 16. Except a pair with abnormal wings, the wing shape of F_1 is very close to that of wild *kotoensis*. Their colors and stripes were of the intermediate apperance between their parents. But most individuals tended to bear the bright-colored metallic luster as in *kotoensis* (Figs. 5－8). Genetically, it should be explained by the heredity of the incomplete dominance: the gene(s) of *kotoensis* is revealed in an extensive degree.

F_2 and backcrossed individuals

Afterward, I selected 3 pairs of male and female from the adults of hybrid F_1 in order to make a $F_1 \times F_1$ test (Figs. 9, 10). Moreover, I selected 2 females of F_1 for backcrossing (Figs. 11－14). At the end of May, 42 F_2 adults were obtained (not including the one with abnormal wings). The variations in the wing shape, colors and stripes of F_2 were conspicuous. As shown in Table 2, hybrid F_1 had enough reproductive ability. Therefore, the judgement that *kotoensis* belongs to *P. bianor* might be

Table 1. Fertility of the F_1 hybrid (♀ *kotoensis* × ♂ *takasago*).

Date of oviposition	Eggs laid	Eggs blackened	Eggs hatched	Pupae produced	Adults Produced
March 3, 1987	2	1	1	1	0
5	28	25	25	23	21
6	10	5	5	5	5
7	5	0	—	—	—
8	18	2	2	2	2
9	16	1	1	1	1
10	18	0	—	—	—
11	15	0	—	—	—
12	13	0	—	—	—
13	6	0	—	—	—
14	11	0	—	—	—
15	5	0	—	—	—
16	6	0	—	—	—
17	4	0	—	—	—
Total	157	34	34	32	29 (♂ 18, ♀ 11)

Table 2. Fertility of the F_2 hybrid and backcrossed individuals. F_1 : ♀ *kotoensis* × ♂ *takasago*.

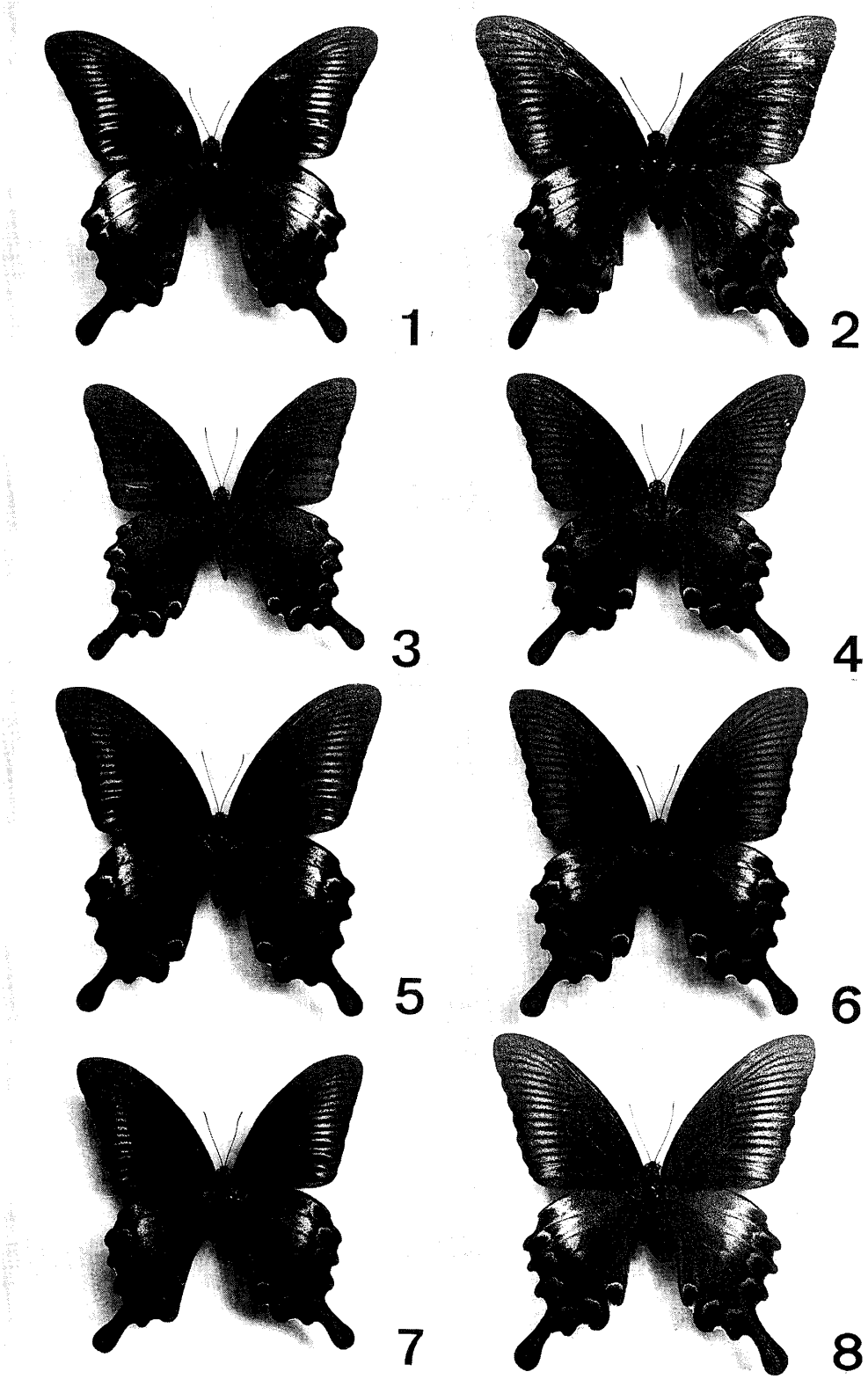
Parent (Brood)	Eggs laid	Eggs blackened	Eggs hatched	Pupae produced	Adults ♂	Produced* ♀
$F_1 \times F_1$ (No. 1)	82	78	75	5	1	2
$F_1 \times F_1$ (No. 2)	53	51	36	9	5	1
$F_1 \times F_1$ (No. 3)	93	70	55	6	5	1
♀ *kotoensis* × ♂ F_1	55	47	43	13	8	4
♀ *takasago* × ♂ F_1	110	108	105	23	11	4

* : except individuals with abnormal wings

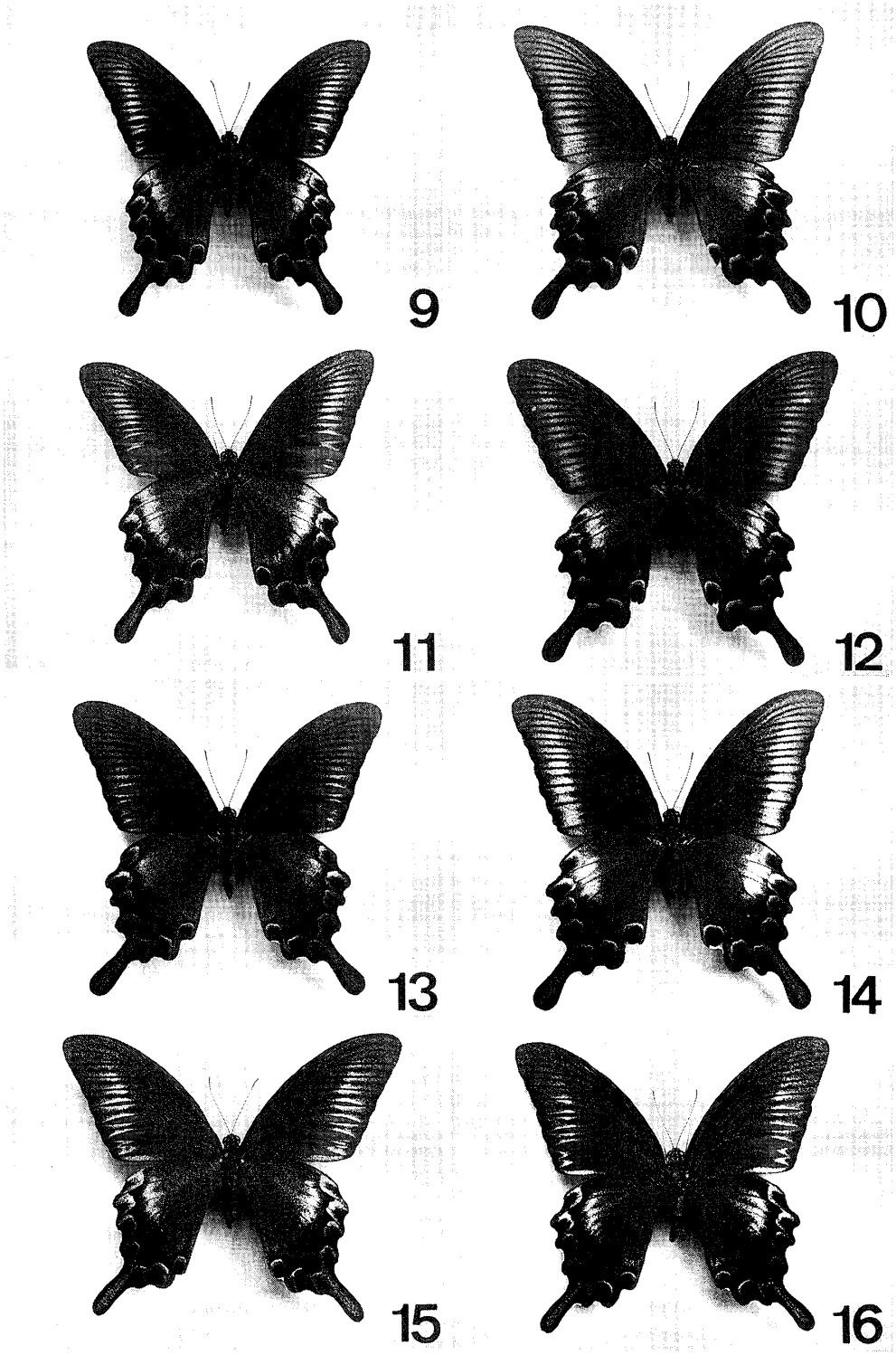
reasonable.

Other Observational Report

In 1987, 31 pupae of hybrid F_1 and 56 pupae of hybrid F_2 were obtained in early April and in mid May, respectively. They were all the diapausing pupae. But, as mentioned above, 12 out of 39 pupae of throughbred *kotoensis* obtained in May entered diapause. Evidently, the hybrids of F_1 or F_2 did not enter diapause in April and May in Taiwan because of the hereditary factor of *takasago*. In general, diapause in some butterflies is induced not only by the environmental factors such as daylength, humedity and temperature, but by the hereditary factor. The upper side of wings, which originally had the strong green and blue metallic luster, became gradually dimmer in the adults emerged from pupae diapausing for a long period or the adults obtained after culturing 2 – 3 generations in the thoroughbred *kotoensis* fed in Taiwan. In general, post-natal evironment could also exert certain influences on the manifestation of heredity variations.



Figs. 1–8. *Papilio bianor kotoensis, P. bianor takasago* and F_1 hybrids.
1. *P. bianor kotoensis* ♂, Lanyu; 2. *Ditto* ♀, *Lanyu*; 3. *P. bianor takasago* ♂, Taiwan; 4. *Ditto* ♀, Taiwan; 5–8. F_1 hybrids (♀ *kotoensis* × ♂ *takasago*). 5, 7: ♂; 6, 8: ♀.



Figs. 9－16. F_2 hybrids and backcrossed individuals. 9. F_2 ♂; 10. F_2 ♀; 11. Backcrossed individual ♂ (♀ *kotoensis* × ♂ F_1); 12. *Ditto.* ♀; 13. Backcrossed individual ♂ (♀ *takasago* × ♂ F_1); 14. *Ditto.* ♀; 15. F_2 of *kotoensis* cultured without overwintering; 16. F_2 of *kotoensis* emerged after diapausing over six months.

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摘　　要

台湾産カラスアゲハ2亜種の交配に関する研究（張　永仁）

台湾産の*Papilio bianor takasago*と紅頭嶼産の*P. bianor kotoensis*は別種として扱われることがある。本研究で両者を人工的に交配させたところ，得られたF_1は十分な妊性を有することが明らかになった。白水（1960）が指摘したように両者は1つの種に属すると考えるのが適当である。（文責　編集部）

（Received 27 July 1988）

Published by the Lepidopterological Society of Japan, c/o Ogata Hospital, 3-2-17 Imabashi, Chuo-ku, Osaka, 541 Japan